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## INTERACTIONS BETWEEN THE PREDATORS *PHIDIPPUS AUDAX* (ARANEAE: SALTICIDAE) AND *HIPPODAMIA CONVERGENS* (COLEOPTERA: COCCINELLIDAE) IN COTTON AND IN THE LABORATORY<sup>1</sup>

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**ABSTRACT:** Visual censuses in Mississippi late-season cotton indicated that the jumping spider *Phidippus audax* was not capturing the ladybird beetle *Hippodamia convergens*, though both were abundant and co-occurring. Laboratory feeding trials demonstrated that *P. audax* would consume a variety of prey, but not *H. convergens*. This suggests the possession of effective defensive mechanisms by *H. convergens* against predation by *P. audax*.

The Convergent Lady Beetle, *Hippodamia convergens* Guerin (Coleoptera: Coccinellidae), is an important beneficial insect distributed throughout the United States and parts of Canada and Mexico (Gordon 1985). This species may be quite abundant locally and is a voracious consumer of aphids (Hagen 1962). In the Delta area of Mississippi, *H. convergens* is abundant in early season on cotton (Dinkins *et al.* 1970) and late season in field margins (Young, unpubl. data). The Jumping Spider *Phidippus audax* (Hentz) (Araneae: Salticidae) is one of the most frequently reported spiders in North America (Taylor and Peck 1975) and is one of the most common spiders in agricultural crops and adjacent habitats (Edwards 1980). In the Delta, *P. audax* is active from March to December and has been recorded preying upon a wide size range and taxonomic diversity of arthropods (Lockley and Young 1986, Young 1988, Young and Lockley 1988). These prey items, however, have not included species of *Hippodamia*. The purpose of this report is to examine the relationship between *P. audax* and *H. convergens* by documenting: (1) the population densities of *P. audax*, *H. convergens*, and other potential spider prey in an old-field site, (2) the frequency of capture by *P. audax* of *H. convergens* and other arthropods, and (3) the results of laboratory feeding trials in which *P. audax* was offered *H. convergens* and three locally abundant crop pests, *Diabrotica undecimpunctata* Barber (Coleoptera: Chrysomelidae), *Nezara viridula* (L.) (Heteroptera: Pentatomidae), and *Lygus lineolaris* (Palisot) (Heteroptera: Miridae).

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## METHODS AND RESULTS

Field observations and censuses were conducted during the period 17-31 October 1986 in an old-field habitat managed for wildflowers at the Delta States Research Center, Stoneville, Washington County, Mississippi. This 0.1 ha field contained two center rows of nectaried cotton that had not been harvested and was reflowering. Censuses of the arthropods on cotton were conducted by slowly walking the length of a row (25m) in approximately 10 minutes, recording all arthropods seen on the plants. When *P. audax* was observed, the identity of any captured prey was also recorded. At other times, individuals of *P. audax* on cotton and adjacent plant species were observed for five-minute intervals and their hunting success recorded.

Thirty-five censuses on 7 days were conducted during the period 17-31 October 1986, and 18 prey records for *P. audax* were obtained (Table 1). The highest predation rates were on species that did not occur frequently or in high densities, i.e. *Spissistilus festinus* (Say) (Homoptera: Membracidae) and "other" spiders. *Hippodamia convergens* had one of the highest densities and frequencies of occurrence, yet records of capture by *P. audax* were not obtained.

Observations on other plant species at this site provided 40 additional prey records for *P. audax* (Young 1988). None of these records included *H. convergens*, though the species was abundant. It was concluded that *P. audax* was rejecting *H. convergens* as a prey item or was unable to capture the beetle. The relationship was therefore examined further under laboratory conditions.

Fifteen adult female *P. audax* were captured during October in Stoneville on *Erigeron* sp. (Compositae), brought into the lab, and maintained in individual clear plastic containers (7cm high x 10cm diameter) in a shaded window at approximately 24°C. After 5 days without food, each spider (body length = 13mm, n = 15) was offered one active tarnished plant bug, *Lygus lineolaris* (b.l. = 5mm, n = 15). Within 5 days, 14 of the 15 spiders had consumed the insect. Those 14 were then each offered one active southern green stink bug, *Nezara viridula* (b.l. = 12mm, n = 14). After 6 days, 12 of the 14 spiders had consumed their stink bug. The 12 successful predators, all with identical feeding histories over the previous 16 days, were then each offered one active convergent lady beetle, *Hippodamia convergens* (b.l. = 6mm, n = 12). No consumption occurred in the next 6 days. Each spider was finally offered one active spotted cucumber beetle, *Diabrotica undecimpunctata* (b.l. = 6mm, n = 12). Within three days, 11 of the 12 spiders had consumed their insect. This sequence of events indicates that *P. audax* did not consume *H. con-*

*vergens*, even in a contrived laboratory situation in which the spider was starved and the beetle could not escape.

## DISCUSSION

It is reasonable to hypothesize that *P. audax* is capable of distinguishing *H. convergens* from other potential prey, that the spider is capable of capturing the beetle, and that *H. convergens* is somehow either distasteful/toxic to *P. audax* or a mimic of such an organism. Jumping spiders (Salticidae) are visual hunters with superior image-detecting and pattern recognition capabilities, and with some color-detecting abilities (Foelix 1982). There is little doubt that *P. audax* can detect the presence of *H. convergens* and that the beetle is within the acceptable prey range for size, shape, and degree/type of movement. The color pattern of *H. convergens*,

Table 1. Arthropod populations and *P. audax* predation rates on cotton foliage. Based on 35 censuses during the period 17-31 October 1986.

Taxon	No. of observations	Freq. of occurrence (%) <sup>1</sup>	Predation rate (%) <sup>2</sup>
<i>Phidippus audax</i>	237	77	-
<i>Diabrotica undecim.</i>	201	100	1.9
<i>Hippodamia convergens</i>	108	83	0
Diptera spp.	53	77	3.7
<i>Spissistilus festinus</i>	49	51	10.2
<i>Lygus lineolaris</i>	46	60	4.3
Hymenop., Ichneumon.	27	46	3.7
Other insects <sup>3</sup>	129	97	0
Other spiders <sup>4</sup>	35	51	11.4

<sup>1</sup>Calculated as the number of censuses in which observed, divided by the total number of censuses (35) times 100.

<sup>2</sup>Calculated as the number observed as prey of *P. audax* divided by the total number observed.

<sup>3</sup>Heteroptera: Pentatomidae, Miridae, Reduviidae, Lygaeidae. Homoptera: Delphacidae, Cicadellidae. Coleoptera: Chrysomelidae, Curculionidae, Carabidae. Lepidoptera: Tortricidae, Hesperidae. Orthoptera: Gryllidae. Hymenoptera: Halictidae. Mecoptera: Panorpidae. Odonata: Coenagrionidae.

<sup>4</sup>*Eris* sp., *Marpissa* sp., *Metacyrba* sp., *Misumenops* sp., *Metaphidippus* sp., *Neoscona* sp., *Oxyopes* sp., *Pardosa* sp., *Schizocosa* sp., *Thiodina* sp., *Zygoballus* sp.

however, may be the cue that indicates to *P. audax* that the prey is unacceptable. This pattern, red-orange with contrasting black, is characteristic of a large group of organisms that are aposematically colored and toxic to certain predators or mimics of toxic models (Ford 1975). Ladybird beetles (Coccinellidae) such as *H. convergens* emit strongly alkaloid hemolymph from their leg joints when disturbed and thus are well protected from attack by such predators as quail and ants (Harborne 1982). It is possible that the adult female spiders used in the previously described laboratory feeding trials had prior experience with *H. convergens* and had discovered their distasteful properties. Experiments with naive 1st instar *Phidippus regius* C.L. Koch and noxious ants have indicated that unfavorable encounters lead to subsequent avoidance (Edwards 1980).

However, the non-consumption of *H. convergens* by *P. audax* may have a geographic component. Laboratory feeding trials with *P. audax* from north-central Oklahoma indicated a consumption of both larval and adult *H. convergens* (Bailey and Chada 1968). *Phidippus audax* individuals from south-west Virginia have also been demonstrated in the laboratory to consume adults and larvae of *Hippodamia parenthesis* Say (Howell and Pienkowski 1971). The possible intraspecific variation in production of noxious substances by *H. convergens*, and/or similar variation in sensitivity to such substances by *P. audax*, would not be an unusual situation (Harborne 1982). Utilizing naive lab-reared adult and immature *P. audax* and larval and adult *H. convergens* from several locations, additional feeding experiments are contemplated to examine in more detail the interactions between these two predators.

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## SOCIETY MEETING OF OCTOBER 19, 1988

When a caterpillar molts it sheds its skin, yet this tissue contains nutrients that can be recycled. Dr. William Cain, an instructor in the School of Life and Health Sciences at the University of Delaware, has been studying how a caterpillar can lose its skin and in a sense save it at the same time. His talk to the first membership meeting of the 1988-89 season was entitled, "Processing Cuticle Proteins in the Larval-Pupal Molt in *Manduca sexta*."

The cuticle of the tobacco hornworm, *M. sexta*, contains 7% of the protein in the larva. Conveniently, molting fluid containing proteolytic enzymes can be sampled from the larval horn at various defined times through the larval-pupal molt. Contrary to the expectation that cuticular proteins would be degraded to smaller peptides, the only proteins observed by gel electrophoresis of the molting fluid were larger and they did not show signs of destruction during the molt. Abruptly before pupation the molting fluid is transferred in bulk to the gut where, 3 days after molting, it begins to be digested. Eventually after 9 days the proteins of the molting fluid disappear. It remains to be determined whether the cuticular proteins are direct or indirect precursors of the proteins in molting fluid.

Fourteen members and 8 guests attended Dr. Cain's talk in Townsend Hall, Newark. They appreciated his clear explanations of insect physiology and his careful observations of subtle morphological changes that precede molting.

In notes of local entomological interest, Dr. Bill Day reported a success for the USDA Beneficial Insects Laboratory. *Peristenus digoneutis*, a braconid wasp from Europe, has become established as a parasite of the tarnished plant bug, *Lygus lineolaris*, in northern New Jersey where it overwintered last year. Dr. Hal White reported the first records of the dragonfly, *Brachymesia grandidis*, for Delaware. A well established population of this brackish-water species was discovered at the Woodland Beach Wildlife Area near Smyrna, DE. This is the northernmost record of this species in the United States.

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